



NASA SBIR 2004 Phase I Solicitation

B1.03 Materials Science for In-Space Fabrication and Radiation Protection

Lead Center: MSFC

Participating Center(s): ARC

Methods for conducting materials science and technology research required to enable humans to safely and effectively live and work in space are needed. Other areas of interest are the development of reduced gravity materials processing technology for in-space fabrication, repair, and resource development. Equipment that can operate with the limited resources of the Space Station Glovebox and in existing Space Station racks to perform demonstration experiments of strategic interest for in-space fabrication and repair, and for development of *in situ* resources, would also be of interest. Innovative developments are sought in the following research areas and their enabling technologies, including commercial applications on Earth.

In-Space Fabrication

NASA needs the development of techniques and processes that permit in-space fabrication of critical path components of future major projects. Developmental studies of materials and processes of direct strategic significance to the exploration of space are appropriate. In addition, the manufacture or repair of components during a mission is essential to human exploration and the development of space. Fabrication and repair beyond low-Earth orbit is required to reduce resource requirements and spare parts inventory, and to enhance mission security. Also being sought are enabling technologies that can lead to materials and/or processes for the reduced gravity (micro-g, 1/6g, and 3/8g) in-space fabrication of *in situ* space resources. Of particular interest is the effect of reduced gravity and the space environment on these processes. Examples of the types of research include but are not limited to the following:

- Application of rapid prototyping technology to low gravity, 3/8 and 1/6 g level free-form fabrication of near-net shapes from metals, ceramics and polymers for fabricating spare parts and repairs.
- Development of space resources into raw materials and feedstock for use with rapid prototyping technology.
- Novel and innovative methods for processing materials in reduced gravity, in-space fabrication and repair including microwave processing, sintering, welding, and joining.
- Development of an improved lunar and Martian regolith simulant material more suitable for materials experiments with not just an average composition, but also the mineralogical analysis, particle shape, size, and distribution of the individual particle grains being more representative of actual lunar and Martian soils.
- Basic research, theoretical modeling, and experimental development of extractive and reactive processes, materials purification and characterization in a reduced gravity (3/8g and 1/6g) space environment and fundamental studies of in-space fabrication with *in situ* resources. For example: *in situ* fabrication of solar cells; metallic wire suitable for electrical conductors, antennas and rectifying-antennas; glass formation from

in situ resources with minimal terrestrial components.

Radiation Protection Materials

NASA needs materials and novel concepts for effective radiation shielding in support of human exploration of space. These materials must be capable of attenuating exposure levels due to galactic cosmic rays and solar energetic particles, as well as their secondaries, to acceptable limits. Specific areas of interest include:

- Development of multi-functional and/or smart structural materials for radiation hardening/shielding;
- *In situ* regolith radiation shielding research;
- Development of light-weight, hydrogenated epoxy and preimpregnates (prepregs);
- Development of hydrogen filled, carbon nanostructures for both radiation shielding and as structural elements for spacecraft and habitat; and
- Methods for monitoring/dosimetry for space radiation.